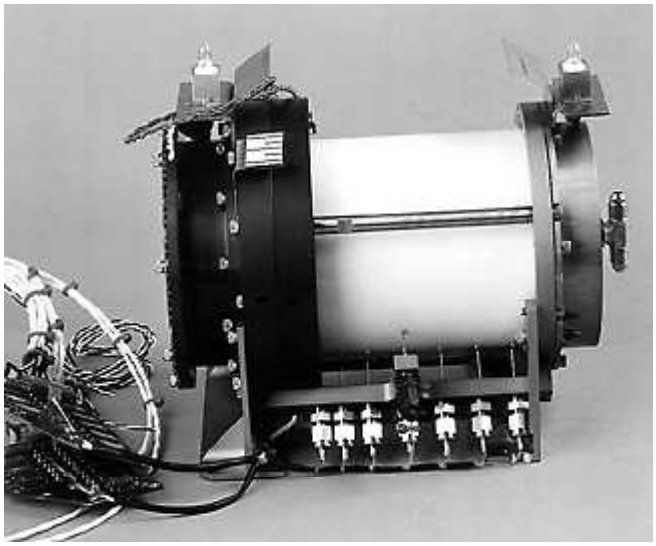
Smoldering News From STS-77 Endeavour



Microgravity Smoldering Combustion fuel sample and test section assembly.

The Microgravity Smoldering Combustion (MSC) experiment lifted off aboard the Space Shuttle Endeavour for its second flight in May 1996, as part of the STS-77 mission. This experiment is part of a series of studies focused on the smolder characteristics of porous combustible materials in a microgravity environment. Smoldering is a nonflaming form of combustion that takes place in the interior of combustible materials. Common examples of smoldering are nonflaming embers, charcoal briquettes, and cigarettes.

The objective of this study is to provide a better understanding of the controlling mechanisms of smoldering in microgravity and normal Earth gravity (1g). As with other forms of combustion, gravity affects the availability of air and transport of heat, and therefore, the rate of combustion. The results of the microgravity experiments will be compared with identical ones carried out in 1g. In addition, they will be used to verify present theories of smolder combustion and will provide new insights into the process of smoldering combustion, enhancing our fundamental understanding of this frequently encountered combustion process and guiding improvements in fire safety practices.

Two smoldering combustion tests with polyurethane foam were successfully accomplished during the STS-77 mission. The tests investigated smoldering combustion in a quiescent (no-flow) enriched oxygen environment, and in an air environment with a 2-mm/sec airflow through the fuel sample. The primary data from the tests are the ignition characteristics, spread rate, smolder reaction temperature, and products of combustion (solid and gas).

On both the first mission on STS-69 and the second mission on STS-77, a smolder front propagated the length of the forced-flow samples, with the spread rate between the corresponding upward and downward 1g smolder rates. Neither of the quiescent cases

propagated combustion (the first case was due in part to a problem with the experiment electronics). These results show a dramatic difference from the normal gravity results, where smolder propagation is very rapid and complete for both of these conditions.

The experiment was conceived by Prof. A. Carlos Fernandez-Pello at the University of California-Berkeley. The MSC hardware was designed and built at the NASA Lewis Research Center by a team of civil servants and contractors from NYMA, Inc., and Aerospace Design & Fabrication, Inc. (ADF). The hardware consists of two sealed aluminum combustion chambers (each being a half a cylinder). The chambers hold the MSC test section, data acquisition electronics, power distribution electronics, and instrumentation. The hardware is fitted into a 5-ft^3 Get-Away-Special (GAS) canister that is mounted in the shuttle cargo bay. The test section (shown in the figure) consists of a quartz cylinder that contains the polyurethane foam sample and an igniter. This igniter, which is an electrically heated wire sandwiched between two porous ceramic disks, is mounted in contact with the end of the foam sample. An array of 12 thermocouples placed axially and radially along the foam sample provide temperature histories, which are used to determine the rate of smolder propagation, and the characteristics of the reaction.

Lewis contact: John M. Koudelka, (216) 433-2852, John.Koudelka@grc.nasa.gov
Authors: John M. Koudelka and Prof. A. Carlos Fernandez-Pello
Headquarters program office: OLMSA (MSAD)